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المدرســـة الوطنيـــة العليـــا في الأمن السيبراني
Foundation Training Department
قســم التكويـن القـاعدي

LEVEL : 1st Year Basic Training

Midterm Standard Answer Key

MODULE : Computer Architecture1

Exercice 1 : (7.5 Pts)

1) Perform the following conversions: **5.5 pts (0.25 pts for each correct answer)**

Base =10	Base =2	Base =8	Base =16
39,875	100111.111	47.7	27.E
$16^2 + 2^5 + 2^3 + 16^{-1}$	100101000.0001	450.04	128.1
53.875	110101.111	65,7	35.E
61.25	00111101.0100	75.2	3D,4

$E6A_{(16)} = 111001101010_{(2)} = 100101011111_{(Gray)}$

$1100011_{(Gray)} = 1000010_{(2)} = 66_{(10)}$

Number	Base =2	BCD	Ecess-3
$126_{(8)}$	1010110	1000 0110	1011 1001
$31_{(16)}$	110001	0100 1001	0111 1100

2) Perform the following operation in BCD: **$126_{(8)} + 31_{(16)}$**

BCD

86   1000 0110
+ 49   + 0100 1001
1100 1111 **(1pts)**

We have :
1111 > 1001
1100 > 1001
So, we must add 0110 to 1111 and to 1100. **(0.5pts)**

$^{1\,1}110^{1}0\ \ 1111$
$+\ 011\ 0\ \ 0110$

Final resut (0001 001 1 0101)$_{BCD}$ **(0.5pts)**
(1 3 5)$_{10}$

Exercice 2 : (4.5 Pts)

a) Find the codes corresponding to the word “**PNG**” according to the above table: **(0.25 pts for each correct answer)**

The word	Code		
	Base =10	Base =16	Base =2
PNG	80 78 71	50 4E 47	1000000 01111000 01110001

b) Determine the Decimal, Sign and Magnitude, 1's complement, and 2's complement values for the following cases (using 9 bits): **(0.25 pts for each correct answer)**

Decimal	Sign and magnitude	1'complement	2'complement
+25	000011001	000011001	000011001
-40	100101000	111010111	111011000
-26	100011010	111100101	111100110

c) Perform the following operations using 7 bits in 2's complement, then provide the results in decimal:

- **$-2D_{(16)} + 23_{(8)}$**
- **$+45_{(8)} + 2E_{(16)}$**

$-2D_{(16)} = 1010011_{(C2)}$ (0.25 pts) **$+23_{(8)} = 0010011_{(C2)}$ (0.25 pts)**	(sur 7 bits)	**$+45_{(8)} = 0100101_{(C2)}$ (0.25 pts)** **$+ 2E_{(16)} = 0101110_{(C2)}$ (0.25 pts)**

$-2D_{(16)}$ $1^{1}010^{1}0^{1}11$ **$+23_{(8)}$ $\underline{+0\ 0\ 10\ 0\ 11}$** **$1\ 1\ 00\ 110_{(C2)} = -011010_{(2)}$ (0.25 pts)** **$= -26_{(10)}$ (0.25 pts)**	**$+45_{(8)}$ 0100101** **$+2E_{(16)}$ $\underline{+\ 0101110}$** **1010011(0.25 pts)** **Incorrect result (Overflow) (0.25 pts)**

Exercice 3 : (4 pts)

1) Provide the ANSI/IEEE 754 representation in single precision (32 bits) for the following numbers:

$-39.875\times2^{-107}{}_{(10)} = -100111.111_{(2)} \times2^{-107} = -1.00111111_{(2)} \times2^{5}\times2^{-107} = -1.\ 00111111_{(2)} \times2^{-102}$ (0.5 pts)

The normalised number is $-1.\ 00111111_{(2)} \times2^{-102}$

- **S = 1**
- **M = 00111111**
- **Exp = -102 => BE= Exp +127 = -102+127 = $25_{(10)}$ = $11001_{(2)}$**

1	00011001	00111111000000000000000	(0.5 pts)
S	BE	M	

$+53.25\times2^{-133}{}_{(10)} = +110101.01_{(2)} \times2^{-133} = +1.1010101_{(2)} \times2^{5}\times2^{-133} = +1.\ 1010101_{(2)} \times2^{-128}$ (0.5 pts)

Impossible to represent $+53.25\times2^{-133}{}_{(10)}$ in single precision (32 bits) (0.5 pts)

<u>OR:</u>

The denormalised number is $+0.011010101\times2^{-126}$

- **S = 0**
- **M = 011010101**
- **BE = 0**

0	00000000	01101010100000000000000	(0.5 pts)

1) Express the values of X and Y, corresponding to the following ANSI/IEEE 754 representations, in the form $\pm M*2^{Er}$ (where M and Er are decimals):

X = $10010011111000000000000000000000_{(2)}$

1	**00100111**	**11000000000000000000000**

0<BE<255 => The number X is Normalised

- **S = 1 => X<0**
- **BE = $00100111_{(2)} = 39_{(10)}$ => Exp = BE – 127 = 39-127 = $-88_{(10)}$**
- **M = 1.mantissa = $1.11_{(2)} = 1.75_{(10)}$**

Thus, X = $-1.11_{(2)} \times 2^{-88} = -1.75_{(10)} \times 2^{-88}$ (1 pt)

Y = $10000000010000000000000000000000_{(2)}$

1	**00000000**	**10000000000000000000000**

BE = 0 and mantissa ≠0 => The number Y is Denormalised

- **S = 1 => Y<0 (0.25 pts)**
- **BE = 0 (0.25 pts)**
- **M = 0.mantissa = $0.1_{(2)} = 0.5_{(10)}$ (0.25 pts)**

Thus, Y = $-0.1_{(2)} \times 2^{-126} = -0.5_{(10)} \times 2^{-126}$ (0.25 pts)

Exercice 4 : (4 pts)

1) Consider the following Boolean function: $F(X,Y,Z)=X.Z + X(\bar{Z}.Y + Z.\bar{Y})$

1. the truth table for **F (1pt)**

X	Y	Z	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

2. The two canonical form of **F**

- **The 1st** canonical form: Sum of Products (SOP)

$F(X,Y,Z) = X\bar{Y}Z + XY\bar{Z} + XYZ = \sum(5,6,7)$ **(0.5 pts)**

- **The 2nd** canonical form: Product of Sums (POS)

$F(X,Y,Z) = (X+Y+Z)(X+Y+\bar{Z})(X+\bar{Y}+Z)(X+\bar{Y}+\bar{Z})(\bar{X}+Y+Z) = \prod(0,1,2,3,4)$ **(0.5 pts)**

3. The simplified expression of F using Boolean algebra is:

$$F(X,Y,Z) = XZ + X(ZY + \bar{Z}Y)$$
$$= XY + X\bar{Y}Z + XY\bar{Z}$$
$$= XY(1+\bar{Z}) + X\bar{Y}Z$$
$$= XY + X\bar{Y}Z$$

$= X(Y + \overline{\boldsymbol{Y}}Z)$

$= X(Y + \mathbf{Z})$

$= XY + XZ$ **(1 pt)**

1. the Logic-Diagram of the simplified **F** using the **NANDs** logical gates is below **(1 pts)**